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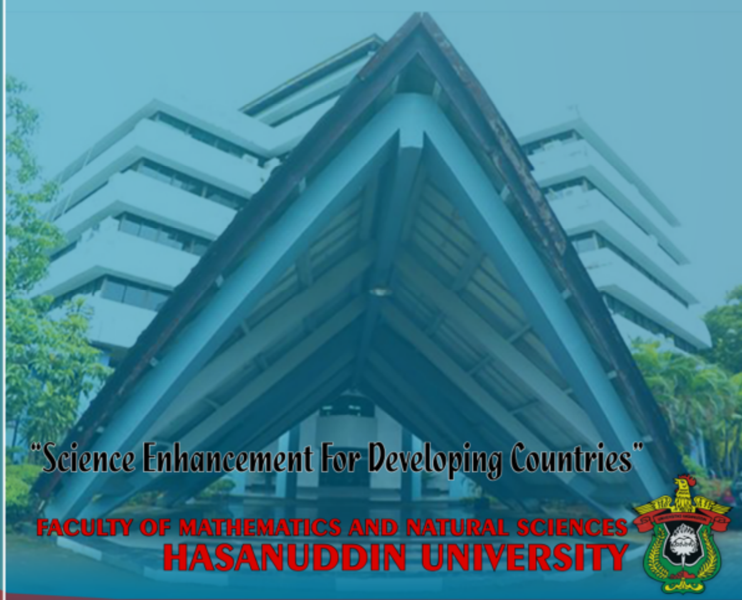

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Community Analysis of Burrower Shrimp in Bonebatang Seagrass Bed South Sulawesi

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Abstract

Burrower shrimp is an important infaunal group on seagrass ecosystem due to their role in sediment aeration, water exchange, mixing the sediment and improving sediment nutrient. In Spermonde Archipelago, seagrass bed are abundant and covering every island reef flat. However, information about burrower shrimp remains less known. Based on this, research about community analysis of burrower shrimp has been conducted in Bonebatang, an uninhabitant island close to Barranglompo Island, South Sulawesi. The aim of this research was to investigate species composition and diversity of burrower shrimp. Samples were collected using plastic tarp method in eight stations. In one station, a sheet of plastic tarp was set up on seagrass bed and another one was set up on bare sand without seagrass as a control. Station 1 to 4 were set up on intertidal zone, station 5 to 7 were set up on subtidal zone, while station 8 was set up on coral reef zone. There were 22 species of burrower shrimp collected from all stations. The highest density of burrower shrimp was Alpheus macellarius which was 2,82 individu/m^2. The diversity of burrower shrimp tend to be higher in control plastic tarp which was 0,33 to 3.18 compared to 0,39 to 0,96 in seagrass bed. Eveness index of uniformness were also showed higher value in control which was 0,49 to 2,33 compared to 0,24 to 0,75 in seagrass bed. Whilst Simpson dominance index showed higher value in control of 0,17 to 0,66 compared to 0,26 to 0,60 in seagrass bed. It can be concluded that species composition and diversity of burrower shrimp on different type of habitat depend on their life modes.

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Key Words: *burrower shrimp, seagrass bed, community analysis, Spermonde Archipelago*

1. INTRODUCTION

Seagrass is the only flowering plants (spermatophyta) that fully adapted in marine environment (Fortes 1990; Waycott *et al.* 2004). This flora mostly found in shallow waters at intertidal zone to subtidal zone at 40 m depth (den Hartog 1970; Hemminga dan Duarte 2000; Waycott *et al.* 2004). The occurrence of seagrass in water column attracted many marine creatures to shelter, forage, spawn and settle. Interactions that occur in this seagrass community, causing the formation of a complex ecosystem that makes seagrass as an important habitat for many species of marine life. Faunal group that found associated with seagrass dominated by sponges (Porifera), sea cucumbers, sea urchins, heart urchin, starfish, brittle stars (Echinodermata), clams, snails (molluscs), shrimp, crab (Arthropoda) and fish (De Wilde *et al.*

1989; Zieman 1989; Erftemeijer *et al.* 1993; Vonk *et al.*, 2008; Priosambodo 2011). Some species of shells, sea cucumbers, shrimp and fish from the seagrass beds have an important economic value for local communities (Tomascik *et al*. 1997).

Burrower shrimp is one group of infaunal organisms that have an important role in seagrass ecosystem. The shrimp population is living by digging and making burrows around stands of seagrass. Most of the shrimp live by cutting seagrass leaves and decomposing seagrass at the base of the pit. Small creatures that live off the seagrass litter decomposition will be eaten by burrower shrimp. Ecologically, seagrass leaf-cutting activity in burrower shrimp will control seagrass populations. In addition, activities bioturbation by making burrows or holes by this shrimp will improve aeration and oxygen levels in the sediment.

Research on the structure of seagrass communities and their associated marine life have been carried out in Indonesia and continued to increase in the last decade (Tomascik 1997). However, most of the research, just only addressed for epifaunal species that live in surface of the sediment. Infaunal organisms that lives inside the sediment still remains unknown (Vonk 2008). Based on this, research related to community analysis of burrower shrimp already implemented. This research was conducted to study the community of burrower shrimp which inhabit the seagrass bed of Bonebatang Island. The study aimed to analyzed the composition of the burrower shrimps in three different types of seagrass habitat.

2. METHODOLOGY

One of the main problems in the study of infaunal organisms is the difficulty to perform sampling of animals that live in the sediment. Some of the tools used to take samples as corer and eickman grab, were less effectively used, because it could not reach burrower shrimp that live in the holes/burrows up to 2 meters below the sediment surface. In addition, the corer method also was more destructive in damaging seagrass directly. Based on this, plastic tarp method was used in this study to sample the burrower shrimp (Priosambodo, 2011).

The method of using plastic tarp (terpal plastik) was done by creating anoxic effects on sediment that will force infauna organisms out of the hole due to lack of oxygen. Anoxic effects created by laying the plastic tarp with dimensions 4 m x 3 m above the sediment. Tarp was then tied to a wooden peg along the sides. Surface tarp then backfilled with sand to close the tarp with the sediment surface and block the entry of oxygen into the hole through the aeration process. Backfilling with sand was applied more on the edge of the tarp. The sand was taken from around the area that was not covered yet. Another purpose of the accumulation of sand was to camouflage tarp. To be easily camouflaged, brown plastic tarp was selected in this study.

2.1 Method of Data Collection

In this study, the sampling area was divided into 16 stations based on the seagrass habitat types found in the Bonebatang Island. Waycott *et. al.* (2004), divided the seagrass habitat in the Indo-West Pacific (including Indonesia) into 6 types of habitats, based on the environmental factors that influence it, e.g: local intertidal, subtidal, coral reef, deep waters, estuaries and coastal mainland. The first three seagrass habitat types: intertidal, subtidal and reef flats can be found in the Bonebatang Island. While the type of seagrass habitat in deep water (with a depth of more than 15 m), were remained unknown.

Placement location of the station was done selectively based on preliminary observations result. Initial observation was generally done through visual observation with a speedboat around the island at low speeds. More detailed observations of activities, carried out by snorkelling in the area of seagrass and reef around the island. Results of preliminary observations indicated the presence of several types of seagrass habitat in Bonebatang Island.

Seagrass on Bonebatang island generally grow clumped (patchy), dominated by mixed communities consisting of several species. Growing seagrass vegetation do not form a whole expanse, because punctuated by many empty areas (bare area) which were not covered by seagrass. This area was generally shaped like large holes dominated by gravel or coarse sand substrate. This hole slightly deeper than the surrounding areas covered by seagrass and known as "blow-out." (Kneer 2006). Type of seagrass dominated by *Cymodocea* sp., *Halodule* sp. and *Thalassia* sp.

Based on the preliminary observations results,16 points were decided to be the station. The first eight stations (stations 1-8) were chosen to be the main station which were placed on the overgrown seagrass habitat types. Furthermore, the next eight stations (station 9-16) functioned as a control station, placed in an empty area (bare area) and were not grown by seagrass, around the main station. The characteristics of each station were described as follows:

Table 1. Description of stations

Station	Description	Location
1	Coral reef, hard substrate, near slope, subtidal	West Side
2	Near beach, intertidal, tide pool, sandy	West Side
3	Intertidal, unstable sandy, very shallow, exposed	East Side
4	Subtidal, sandy, very steep and deep, many *Pinna bicolor*	East Side
5	Intertidal, gravel, rubble, high tidal wave, strong current	North Side
6	Intertidal, very flat, shallow, wide expanse of sand	South Side
7	Intertidal, massive accumulation of sand dune, unstable	West Side
8	Subtidal, steep and deep, very fine sandy substrate	Southeast Side
9 (control)	Coral reef, hard substrate, near slope, subtidal	Near station 1
10 (control)	Near beach, intertidal, tide pool, sandy	Near station 2
11 (control)	Intertidal, unstable sandy, very shallow, exposed	Near station 3
12 (control)	Subtidal, sandy, very steep and deep, many *Pinna bicolor*	Near station 4
13 (control)	Intertidal, gravel, rubble, high tidal wave, strong current	Near station 5
14 (control)	Intertidal, very flat, shallow, wide expanse of sand	Near station 6
15 (control)	Intertidal, massive accumulation of sand dune, unstable	Near station 7
16 (control)	Subtidal, steep and deep, very fine sandy substrate	Near station 8

Bonebatang is small island in Spemonde Archipelago with extensive seagrass bed especially in western and southern side. Seagrass grow patchy and intermittent with bare sand and blow out. Sampling site are shown in the Figure 1 below :

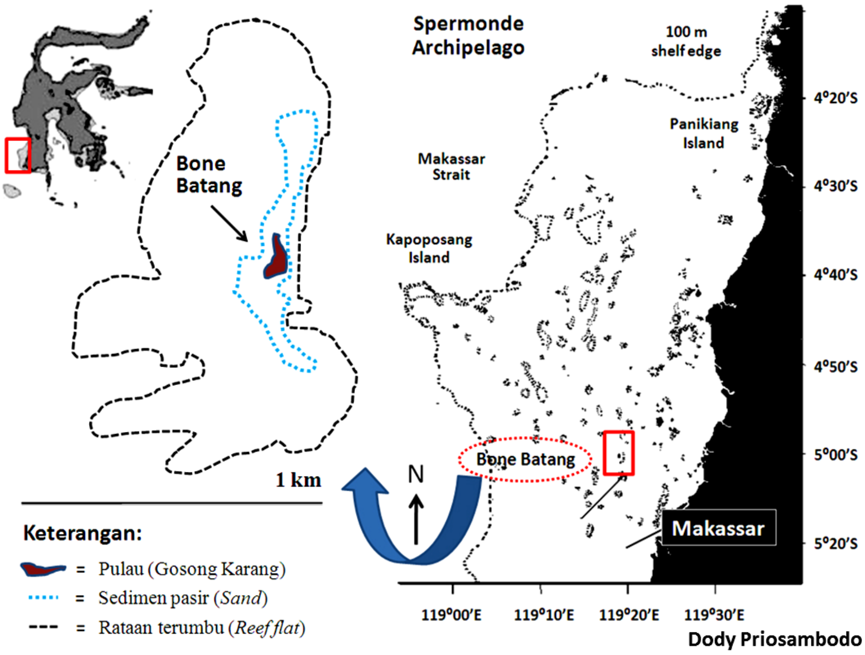

Figure 1. Study Site (Priosambodo, 2011).

The placement of each station based on the preliminary observation on seagrass coverage and density, sediment characteristics, water current, tidal cycle and seagrass fauna. All of macro-epifauna recorded and transferred aside before plastic tarp were set up. Placement of each station and schematic of plastic tarp shown in Figure 2 below:

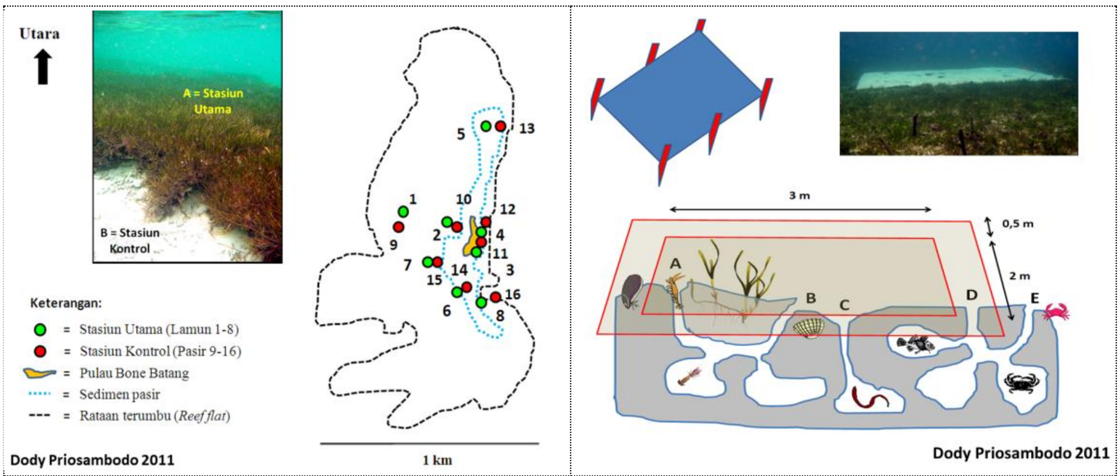

Figure 2. Placement of stations and schematic view of plastic tarp in Bonebatang seagrass bed, South Sulawesi (Priosambodo, 2011).

2.2. Data Analysis

Some ecological parameters which analyzed in this study were:

2.2.1 Species Composition

Species composition was determined by the type of burrower shrimp found at the study site. The number of species and individuals in each station summed and arranged in tabular form.

2.2.2 Species Density

Density is the number of individuals per unit area or volume. In this study, density was expressed as the number of individuals per square meter and formulated as follows:

D = A / b

with: D = density of individuals per m^2; A = Number of individuals macrozoobenthos; b = Area tarp (12 m^2).

2.2.3 Species Diversity

To calculate the value of the diversity, Shannon-Wiener index was used based on the logarithm base 2 (Bengen 2000).

(H ') = -Σ Pi log2 Pi

with: H '= Shannon-Wiener Diversity Index; Pi = ni / N; ni = Number of \ individuals of species i-th; N = total number of individuals. According to Krebs (1985) in Magurran (1988), category diversity level assessment based on the Shannon-Wiener index are as follows: H '≤ 2 = Diversity Low; 2 <H '≤ 3 = Diversity Medium; H '> 3 = High Diversity

2.2.4 Uniformity Index

The Balance of the distribution of a species in the community can be seen from the uniformity index (Brower *et al.* 1998), which is expressed as:

(E ') = H' / H 'Max

with: E '= Uniformity Index; H '= Shannon-Wiener Diversity Index; H 'Max = **LnS**; S = Number of species. Krebs (1985) states that the category rating of uniformity based on uniformity index (E = Equitabilitas) are as follows: 0 <E ≤ 0.5 = Distressed Communities; 0.5 <E ≤ 0.75 = Community labile; 0.75 <E ≤ 1 = Stable Communities

2.2.5 Simpson Dominance Index

The dominance of a species in the community can be seen from the results of the analysis using the Simpson dominance index which is expressed as:

C = Σ (ni / N) 2

with: C = Simpson dominance index;Ni = Number of individuals of species i-th; N = total number of individuals of each species. Category assessment of the level of dominance by Simpson index is as follows (Odum 1983): 0 <C ≤ 0.5 = Distressed Communities; 0.5 <C ≤ 0.75 = Community labile; 0.75 <C ≤ 1 = Stable Communities

4. RESULT AND DISCUSSION

From the results of sampling using plastic tarp in seagrass bed of Bonebatang Island, obtained a total of 22 species of burrower shrimp. The highest density was found in shrimp *Alpheus macellarius* who live in seagrass beds with an average number of individuals by 2.82 individuals/m^2 (Table 1). Density shrimp *Alpheus macellarius* also highest in the control with the number of individuals at 0.79 individuals/m^2 (Table 2).

Tabel 1. Species composition and density of burrower shrimps (individuals/ m^2) in seagrass bed stations of Bonebatang Island.

No	Species of Burrower Shrimp	St.1	St.2	St.3	St.4	St.5	St.6	St.7	St.8	Total	Average
1	*Alpheus macellarius*	6.75	0.83	0.33	4.17	1.83	2.58	4.83	1.25	22.57	2.82
2	*Alpheus spp.*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	*Axiopsis serratifrons*	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.08	0.01
4	*Axiopsis sp.*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	*Callaxina spp.*	0.00	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.58	0.07
6	*Calliax sp.*	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	1.00	0.13
7	*Calliaxina novae-brittaniae*	0.25	0.50	0.50	0.00	0.92	1.83	0.25	0.58	4.83	0.60
8	*Calliaxina sp. (besar-putih)*	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.25	0.03
9	*Coralianassa assimilis*	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.17	0.02
10	*Coralianassa coutierei*	0.83	0.33	1.33	0.42	0.50	2.75	1.33	0.25	7.74	0.97
11	*Coralianassa spp.*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.42	0.05
12	*Eucalliax panglaoensis*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	*Gonodactylus sp.(belang)*	0.25	2.00	0.00	0.75	0.00	0.00	0.00	0.08	3.08	0.39
14	*Lysiosquillina maculata*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	*Mantis sp.1 (Kuning)*	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.08	0.01
16	*Mantis sp.2 (Putih)*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	*Mantis spp*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	*Michaelea sp.*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	*Neaxius acanthus*	0.75	0.00	1.58	0.00	0.00	0.58	0.50	0.33	3.74	0.47
20	*Neocallichirus indicus*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	*Neocallichirus vigilax*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	*Upogebia sp.*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Tabel 2. Species composition and density of burrower shrimps (individuals/ m^2) in bare sand area (control stations) in seagrass bed of Bonebatang Island.

No	Species of Burrower Shrimp	St.9	St.10	St.11	St.12	St.13	St.14	St.15	St.16	Total	Average
1	*Alpheus macellarius*	2.5	0.25	0.75	0	0.25	2.00	0.17	0.42	6.34	0.79
2	*Alpheus spp.*	0.08	0	0.08	5.83	0.00	0.00	0.00	0.00	5.99	0.75
3	*Axiopsis serratifrons*	0	0	0.25	0	0.00	0.00	0.00	0.83	1.08	0.14
4	*Axiopsis sp.*	0	0	0	1.08	0.00	0.00	0.00	0.08	1.16	0.15
5	*Callaxina spp.*	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
6	*Calliax sp.*	0	0	0	0	0.00	2.08	0.00	0.00	2.08	0.26
7	*Calliaxina novae-brittaniae*	0	0.42	0	0	0.00	0.00	0.00	0.00	0.42	0.05
8	*Calliaxina sp. (besar-putih)*	0	0	0	0	0.08	0.00	0.00	0.00	0.08	0.01
9	*Coralianassa assimilis*	0	0.17	0	0	0.00	0.00	0.00	0.00	0.17	0.02
10	*Coralianassa coutierei*	0.92	0.33	1.58	0	1.33	0.75	0.08	0.00	4.99	0.62
11	*Coralianassa spp.*	0	0	0	0.25	0.00	0.00	0.00	0.00	0.25	0.03
12	*Eucalliax panglaoensis*	0.08	0.58	1.08	0.17	0.00	0.17	0.00	0.08	2.16	0.27
13	*Gonodactylus sp.(belang)*	0.83	0.33	0.33	0	0.00	0.33	0.00	0.00	1.82	0.23
14	*Lysiosquillina maculata*	0	0	0	0	0.00	0.08	0.00	0.00	0.08	0.01
15	*Mantis spp*	0	0	0	0	0.42	0.00	0.00	0.00	0.42	0.05
16	*Metapenaeus ensis*	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
17	*Michaelea sp.*	0	0	0	0	0.00	0.00	0.00	0.08	0.08	0.01
18	*Neaxius acanthus*	0	0	1.25	0	0.00	0.00	0.00	0.00	1.25	0.16
19	*Neocallichirus indicus*	0.08	0	0	0	0.00	0.00	0.42	0.00	0.50	0.06
20	*Neocallichirus vigilax*	0	0.08	0	0	0.00	0.25	0.75	0.00	1.08	0.14
21	*Penaeus indicus*	0	0.08	0.17	0	0.00	0.00	0.00	0.08	0.33	0.04
22	*Upogebia sp.*	0.17	0	0.08	0	0.92	0.00	0.00	0.00	1.17	0.15

The highest diversity of shrimp burrower shrimp was found in the control station with values ranging between 0,33-3.18 (Table 3). Uniformity Index (Evenness) was also higher in the control station with values ranging from 0.24 to 2.29. Value of dominance between the main station and the control station was not differ at all from 0.19 to 0.66 (Table 3).

Tabel 3. Shannon Wiener Index, Eveness Index and Simpson Dominance Index of burrower shrimps in seagrass bed of Bonebatang Island.

No	Stations	Shannon-Wiener Index (H')	Eveness Index (E')	Simpson Dominance Index
1	Station 1	0.39	0.24	0.60
2	Station 2	0.89	0.64	0.38
3	Station 3	0.96	0.60	0.32
4	Station 4	0.48	0.34	0.58
5	Station 5	0.82	0.75	0.42
6	Station 6	0.68	0.42	0.26
7	Station 7	0.60	0.31	0.40
8	Station 8	0.52	0.29	0.27
9	Station 9	0.84	0.43	0.36
10	Station 10	2.36	1.14	0.17
11	Station 11	1.06	0.48	0.19
12	Station 12	0.33	0.24	0.66
13	Station 13	1.19	0.74	0.32
14	Station 14	0.85	0.44	0.28
15	Station 15	3.18	2.29	0.38
16	Station 16	2.87	1.60	0.36

Result showed that species composition and diversity of burrower shrimp were higher in bare sand compared to seagrass bed. This interesting fact raises questions: i.e why the bare sand has more shrimps species?. How the shrimp get food for life? or how the shrimp protect themselves when out from the funnel for foraging the food?.

According to Kneer (2013), burrower shrimps have different way to life. *Alpheus macellarius* the most abundance burrower shrimp in seagrass bed are leaf harvester. This Alpheid shrimp collect leaves from small seagrass species such as *Cymodocea rotundata* and *Halodule uninervis.* Seagrass leaves are cut out by their strong claw and brought to the funnels. *Alpheus macellarius* also the most abundance species in bare sand. Some seagrass assemblages become bare because the leaves have been cut out by this shrimp. Another reason is, *Alpheus macellarius* has poor sight, so this shrimp relies on their goby fish-associated to keep watch on surroundings. Sometimes *Alpheus macellarius* clear up the seagrass from around theirs funnels to relieve goby fish role in watch the situation around.

Another larger burrower shrimp species, *Neaxius acanthus,* relies on catching drifting seagrass leaves for its diet (Kneer 2013). For both of this shrimp species, seagrass bed also provide more stable sediment for their funnels. Roots and rhizome of the seagrass bind the sediment from erosion. Build a new funnel is consuming energy and make shrimp in susceptible situation from predators.

In bare sand area without seagrass leaves, many larger burrower shrimps are lives. This shrimps build large mounds and complicated funnels. Bare sand area without seagrass mostly found in deeper (subtidal area) where the watern motion are benign with finer sediment. Larger burrower shrimps such as *Coralianassa coutierei, Neochalichirus vigilax, Eucalliax panglaoensis* and *Caliaxina* sp. are deposit feeder. These shrimps feed on sediment to take organic matter i.e decomposing plants and animals including feces as their diet. The shrimps spend most of their lifetime with sorting large mounts of sediment to get nutrient. Build large and complicated funnels and sorting sediment is easier in sediment without seagrass roots and rhizomes. For this reason, many larger burrower shrimp prefer to live in bare sand area. Burrower shrimp activities in build funnels increase oxygen content in sediment. Sorting sediment by burrower shrimp are also important process for nutrient cycling. Mantis shrimps build their funnels on seagrass bed and bare sand area and even in hard substrate that dominated by of rubbles. These shrimps are not dependent on seagrass leaves or sediment with rich nutrient because they are truly predators. Zebra mantis *Lysiosquillina maculata* is the largest burrower shrimp that directly hunting small fish, shrimp, molluscs and other marine organisms. In Seagrass bed, species composition of seagrass, density of seagrass leaves and sediment characteristic are not the main factor that affect the distribution of burrower shrimps. Burrower shrimps choose their habitat based on how they foraging for food (Table 4).

Tabel 4. Life Modes of Burrower Shrimp

No	Species of Burrower Shrimp	Life Modes
1	*Alpheus macellarius*	Leaves Harvester
2	*Alpheus spp.*	Leaves Harvester
3	*Axiopsis serratifrons*	Scavenger
4	*Axiopsis sp.*	Scavenger
5	*Callaxina spp.*	Deposit Feeder
6	*Calliax sp.*	Deposit Feeder
7	*Calliaxina novae-brittaniae*	Deposit Feeder
8	*Calliaxina sp. (besar-putih)*	Deposit Feeder
9	*Coralianassa assimilis*	Deposit Feeder
10	*Coralianassa coutierei*	Deposit Feeder
11	*Coralianassa spp.*	Deposit Feeder
12	*Eucalliax panglaoensis*	Deposit Feeder
13	*Gonodactylus sp.(belang)*	Carnivor
14	*Lysiosquillina maculata*	Carnivor
15	*Mantis spp*	Carnivor
16	*Metapenaeus ensis*	Scavenger
17	*Michaelea sp.*	Deposit Feeder
18	*Neaxius acanthus*	Leaves Catcher
19	*Neocallichirus indicus*	Deposit Feeder
20	*Neocallichirus vigilax*	Deposit Feeder
21	*Penaeus indicus*	Scavenger
22	*Upogebia sp.*	Deposit Feeder

5. CONCLUSION

From sampling activities, 22 species of burrower shrimp collected from all stations. The highest density of burrower shrimp was found in *Alpheus macellarius* which was 2,82 individu/m^2. The diversity of burrower shrimp tend to be higher in control plastic tarp which was 0,33 to 3.18 compared to 0,39 to 0,96 in seagrass bed. Eveness index of uniformness were also showed higher value in control which was 0,49 to 2,33 compared to 0,24 to 0,75 in seagrass bed. Whilst Simpson dominance index showed higher value in control of 0,17 to 0,66 compared to 0,26 to 0,60 in seagrass bed. It can be concluded that species composition and diversity of burrower shrimp on different type of habitat depend on their life modes.

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